HANDBOOK

FOR

BURIED CABLE

FAULT LOCATOR

MODEL 2785

RYCOM®
INSTRUMENTS

A Division of RAILWAY COMMUNICATIONS, INC.
9351 E. 59TH STREET, RAYTOWN, MISSOURI
Phone: 816–353-2100

RYCOM

MODEL 2785

BURIED CABLE

FAULT LOCATOR

WARRANTY

This instrument is warranteed for one year from date of delivery against defects in material and workmanship. (Exception — dry batteries). We will repair or replace products that prove to be defective during warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

Where it is necessary to return instrument to factory, pack well, ship prepaid to RYCOM INSTRUMENTS, 9351 East 59th Street, Raytown, Missouri 64133. We repair and ship back within two (2) working days any instrument sent in, unless instrument is unrepairable, in which case we will telephone and advise.

Should you encounter difficulty and require assistance, please call RYCOM INSTRUMENTS, Area Code 816/353-2100. Ask for Gene Tuel.

TABLE OF CONTENTS

SECTION	PAGE
Introduction	3
The Equipment	5
Transmitter Matching	7
How To Do It	9
Locating Cable Path & Depth	9
Example 1A Illustration Tracing Path	10
Example 1B Locating Depth	11
Example 2 Shield To Earth Faults	12
Example 2A Illustration Shield Ground	13
Example 2B Illustration Receiver Level Chart	14
Example 3 Grounded Conductor With Shield To Earth Contact	15
Example 3A Illustration Conductor Ground With Shield Ground	17
Example 3B Grounded Conductor Shield Not Damaged	18
Example 3B Illustration Conductor Ground With No Earth Return	19
Example 3C Grounded Conductor High Resistance	20
Example 3C Illustration High Resistance Grounds Shield Not Grounded	21
Example 4 WETS	22
Example 4A Illustration Wets In Encapsulated Sleeve	23
Example 4B Illustration Wets With Metallic Sleeve	25
Example 5 Shorts	26
Example 5A Illustration Short Metallic Loop	27
Example 5B Illustration Short Capacitor Substitution	29
Example 5C Illustration Short Pair Substitution	30
Example 5D Cross	31
Example 5D Illustration Cross	32
Example 6 Cut Cable	33
Example 6A Cut Cable Using Snooper Probe	34
Example 6B Cut Cable Using Ground Return Probe	35
Example 7 Locating Splits	36
Example 7A Illustration Split	37
Example 7B Illustration Corrected Split	38
Back of Book Ramblings	39
Example 8 Illustration Capacitor Substitution Box	40
Example 9 Opens	41
Example 9A Illustration Open Conductor In A Buried Drop Wire	43
Example 9B Illustration Open Conductor In A Buried Drop Wire Using Capacitor Box	44
Example 10 Locating Aerial Troubles	45
Example 10A Illustration Open Conductor In Aerial Cable Using Capacity Probe (Shielded)	46
Example 10B Illustration Open Conductor In Aerial Cable (Unshielded) Using Capacity Probe	48
Example 11 Locate Faults In Buried Secondary & Primary Service Wires	49
Grounded Conductor Phase 1 Buried Secondary Leads	50
Open Conductor Phase 1 Buried Secondary Lead	51
Example 11A Illustration Grounded Conductor 1 Phase Buried Secondary Leads	52
Example 11B Illustration Open Conductor 1 Phase Secondary Lead	53
Specifications – System	54

Introduction

You have just received the finest Buried Cable Fault Locator possible to manufacture. Constant research and development since 1960, is incorporated in RYCOM'S Model 2785. It is not a "cure-all" for all faults that can be present, but in the hands of a capable craftsman, who will use some ingenuity the Model 2785, becomes an almost unlimited tool for locating faults.

There are no hard and fast rules in locating faults. "Success or failure" will depend on craftsman's "knowledge of faults to be located" and "knowledge of this instrument".

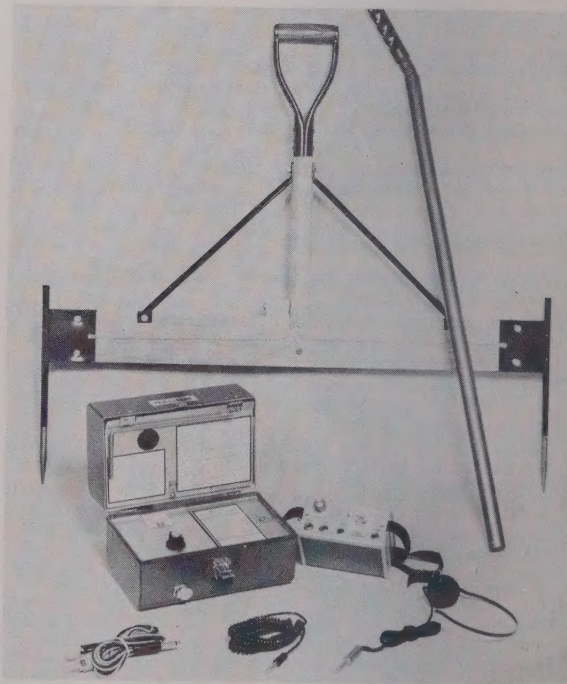
GENERAL RULES

1. Always isolate fault(s) to shortest possible distance with access point at each end.
2. Always completely test faulted circuit to determine exactly what type of fault(s) is causing outage. Always locate fault(s) associated with conductor(s) first.
3. Never – except when locating an OPEN in buried drop – "brute force" fault by increasing power from transmitter. "Brute forcing" fault causes "Flooding", "Carry-Over", "Carry-By". Transmitter signal is forced past fault making it impossible to locate. It also will introduce noise on other circuits in service.
4. While probing a *sudden increase* or *decrease* in signal level on receiver meter indicates operator is approaching or on fault. Exception: Metallic sleeves (Page 15). A gradual decrease in signal level on receiver meter while probing toward *far* access point is NORMAL. Reset reference level on receiver meter.
5. If unable to locate fault from one access point try from other access point. If one method doesn't locate the fault, use your ingenuity; try another method.

This handbook describes the easiest ways to locate faults.

SHOULD YOU ENCOUNTER DIFFICULTY AND REQUIRE ASSISTANCE PLEASE CALL RYCOM INSTRUMENTS, Area Code 816/353-2100 – ASK FOR GENE TUEL.

RYCOM
MODEL 2785



RYCOM®
INSTRUMENTS

THE EQUIPMENT

The Model 2785 is designed for locating faults in direct buried, underground (ducted), aerial telephone cables, underground power distribution cable, CATV (coaxial) cable. Model 2785 locates cable path and depth, shield to earth faults, grounds, wets, shorts, crosses, splits, cuts and OPENS in *buried drop*.

The Model 2785 consists of transmitter, receiver, and two probes. (Ground Return Probe & Snooper Probe). The two transmitter batteries, receiver, two accessory cords, headset, ground rod, and handbook are stored in compartments in transmitter case. Entire package weighs less than twelve (12) pounds, is ruggedly constructed to withstand rigorous field use, and designed to operate in extreme temperature environments.

Model 2785 transmitter is a transistorized oscillator circuit and power amplifier powered with two Eveready 509 lantern batteries (40-50 hours normal use). The transmitter delivers an exact 815 Hz per second signal pulsed at 7 times per second. (Frequency of 815 Hz chosen to provide best separation from 60 Hz power line harmonics.) Signal is coupled to fault through an output switching circuit with a meter to indicate proper fault loading.

RECEIVER

Model 2785 receiver is a transistorized highly sensitive amplifier, powered with 4 Eveready No. 935 "C" flashlight batteries (over 200 hours normal use), weighs less than 2¼ pounds and is furnished with a neck strap allowing full use of both hands when probing, climbing or entering manhole. Receiver is precisely tuned to 815 Hz for maximum reception of transmitter signal. A newly designed bandpass filter is incorporated to reject *all* unwanted signals. Receiver front panel has one control LEVEL so reference point (normally mid-range) can be set on meter for visual observation when probing. A BATTERY TEST push button switch, 3 jacks – HIGH – used with ground return probe or W.E. 111 capacity probe – LOW used with snooper probe or W.E. "101" or "105", Perkins "PR810" or "PR 421" – PHONE – used for headset. NOTE: Head set plug MUST be inserted into PHONE jack before power is connected to receiver.
RECEIVER METER WILL PROVE "INVALUABLE" WHEN PROBING FOR FAULTS AS MINUTE CHANGES CAN BE OBSERVED ON METER THAT CANNOT BE DETECTED BY EAR.

NOTE: Batteries equivalent to above may be used, however, if batteries are left in instrument until electrolysis produces electrolye the Eveready batteries does not allow this acid to escape from battery case as soon as the other batteries tested. REMOVE BATTERIES WHEN INSTRUMENT IS STORED.

GROUND RETURN PROBE

This probe is used for locating all buried cable faults connected to earth, such as shield to earth, wets in metallic splice case, grounded conductor with shield to earth contact, cut cable, and OPENS in buried drop.

SUGGESTIONS USING GROUND RETURN PROBE.

1. LIFT PROBE – TAKE TWO STEPS – DROP PROBE. Weight of probe will force points into earth. NEVER USE ARM TO "JAB" PROBE INTO EARTH.
2. Approximate fault location can be determined by probing 10 to 20 feet OFF to side but PARALLEL to cable path. PROBE ON DIRT SHOULDER OF GRAVEL OR BLACK TOP ROAD. To *pinpoint* fault location probe on cable path.
3. Locate cable path by probing ACROSS suspected path of cable. NULL on receiver meter indicates cable is located directly below handle of return ground probe.
4. Fault & cable path can be pinpointed when receiver meter constantly indicates a NULL as probe is probed in 360° circle.

SNOOPER PROBE

This probe is used for locating path & depth, grounded conductor with no shield to earth contact, shorts, crosses, splits, corrected splits and wets in encapsulated splice cases. Snooper probe can also be used for locating ends of cut cable, as well as locating various faults in aerial cable. Snooper probe has a tuned coil circuit matched to frequency of transmitter. The 45° handle enables user to establish depth of cable by holding snooper probe handle parallel to earth or hold snooper probe so handle points straight up towards sky.

TRANSMITTER MATCHING

Matching of the Model 2785 transmitter to fault is all important, since we need maximum power at the fault without overloading the transmitter and causing excessive battery drain.

The Model 2785 transmitter uses a 7 position switch marked: BATTERY TEST, OFF, 1, 2, 3, 4, 5, and a meter to indicate when the transmitter is correctly matched to a fault.

The meter scale is divided into 3 sections: Position 5, Green and Position 1. After using the transmitter on several types of faults you will become familiar with the various positions of matching. It is recommended that matching normally into the Green position of the meter range will give the best transfer of current to the fault.

HOWEVER

Low resistance faults (100 ohms or less) will match into Position 1. High resistance faults (10,000 ohms or more) will match into Position 5. The Model 2785 transmitter will match into faults from direct metallic to over 500,000 ohms. Note: Transmitter test cord plug must be inserted into output jack (front of 2785 case) before power is connected to transmitter.

RYCOM MODEL 2785

LOCATING CABLE PATH & DEPTH

This is the easiest operation for this instrument.

Short run up to 3000 feet using shield between two access points.

Isolate shield from one access point *only*. Clip transmitter test cord *RED* lead to *shield* and *BLACK* lead to driven ground rod. Insert transmitter test cord plug into transmitter output jack. Set transmitter matching switch for proper match.

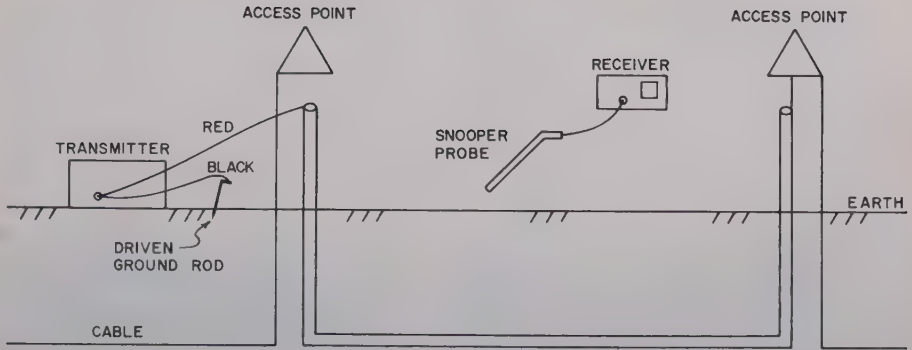
Use snooper probe connected to *LOW* jack of receiver.

NOTE: Using this method there will be a *NULL* (minimum signal) directly over cable and a peak (maximum signal) on either side of cable. Set reference level (normally mid-range) on receiver meter on peak signal on one side of cable. Follow path of cable by observing the *NULL* reading directly over cable.

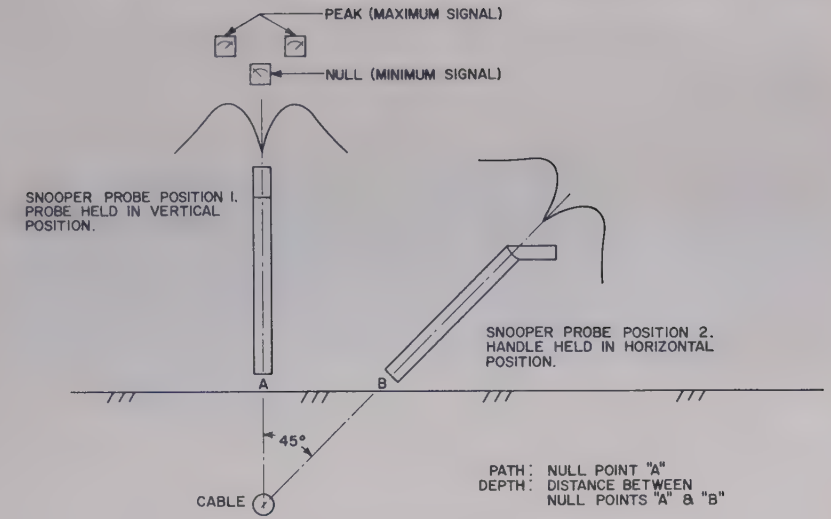
To locate depth of cable hold snooper probe vertically over cable marking the *NULL* as point "A" (see illustration). Now hold snooper probe so handle is parallel to earth (or hold snooper probe so handle points straight up towards sky). Move away at right angle to cable path until another *NULL* is noted. Mark at point "B" (see illustration). The distance between point "A" and point "B" is the depth of cable.

Long runs – up to 25 miles.

Isolate one conductor and clip same to driven ground rod at far access point. Clip transmitter test cord *RED* lead to conductor and *BLACK* lead to *driven ground rod*. Adjust matching as outlined above and follow same procedure.



Example 1a. Tracing Cable Path

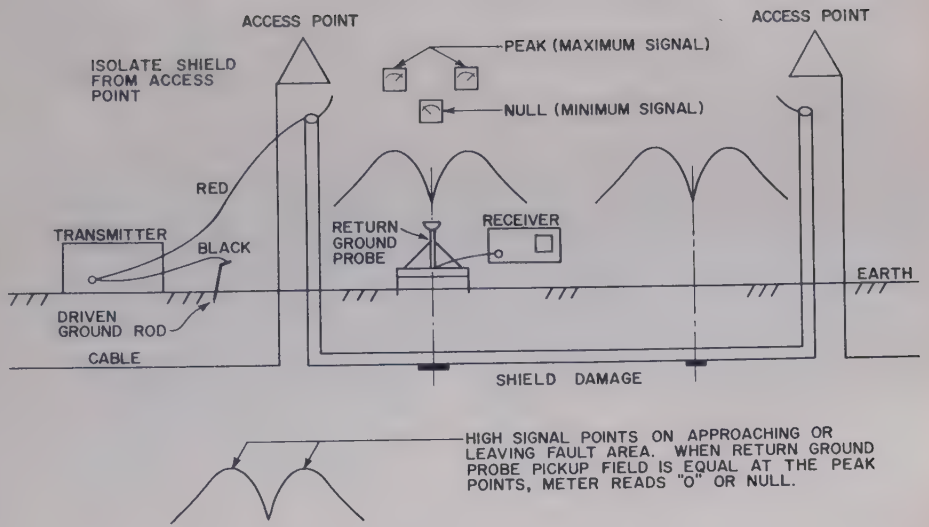


Example 1b. Locating Depth

SHIELD TO EARTH FAULTS

Generally, locating a shield to earth fault is fairly simple. However, if there are any large shield to earth faults on cable it will take more time as a large shield to earth fault will take most of the current from transmitter to earth. It will be necessary to *dig* and *isolate* this large fault before reprobing *entire cable* to locate all other smaller shield to earth faults which could have been missed.

Isolate shield from both access points. Clip Fault Locator transmitter test cord, *RED* lead to *shield* and *BLACK* lead to driven *ground rod.* Insert test cord plug into transmitter output jack. Set transmitter matching switch for proper match of fault. Use *ground return probe* connected to *HIGH* jack of receiver. Set reference point (normally mid-range) on receiver meter. Probe cable path every 4 to 5 feet, resetting reference point on receiver meter as necessary. As fault location is approached signal level will suddenly increase (peak) on receiver meter. *PROBE IN INCHES.* Directly over fault there will be a NULL (minimum signal) on receiver meter. Immediately after passing fault point there will be a sudden increase in signal (peak) on receiver meter. When ground return probe is on cable path and centered over fault (NULL reading on receiver meter), fault is directly in line with handle of ground return probe. Mark exactly, location of each NULL of the peak NULL peak indication seen on receiver meter as cable path is probed. Each *NULL* is a shield to earth *fault.* After digging and examination, some of these might not appear to be damaged. These are small pin holes and should be taped so they will not cause more serious *trouble* later.

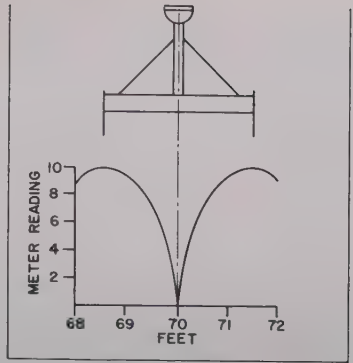


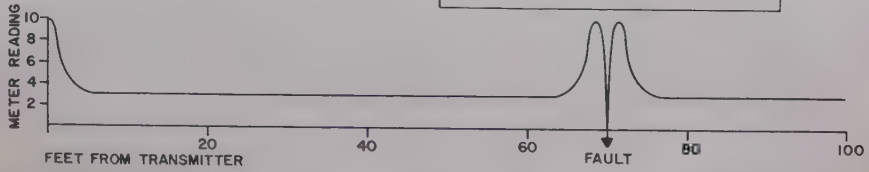
Example 2a. Shield Ground

FIGURE SHOWS TYPICAL RECEIVER METER READINGS FOR CABLE SHIELD GROUND LOCATED 70 FEET FROM TRANSMITTER.

CURVE BELOW REPRESENTS RELATIVE READINGS AS INDICATED ON RECEIVER METER FOR VARIOUS RETURN GROUND PROBE POSITIONS ALONG CABLE PATH.

EXPANDED VIEW SHOWS RELATIVE SIGNAL STRENGTHS IN IMEDIATE AREA OF FAULT. NOTE NULL AT 70 FOOT MARK.





Example 2b. Receiver Level Chart

METALLIC SLEEVES

If metallic sleeves were used on cable under test and ground return probe is used to locate conductor(s) or shield fault to earth there will be a NULL (minimum signal) over each metallic sleeve. If fault is in one of these metallic sleeves NULL will be sharp. NULL over other metallic sleeves will be broad (approximately 3/4 actual length of sleeve). If metallic sleeves were taped and tape still isolates it from earth there will be *NO* indication, (even if fault is present). If tape does not isolate sleeve from earth there will be a NULL over each uninsulated spot.

GROUNDED CONDUCTOR WITH SHIELD TO EARTH CONTACT.

NOTE: There is no way of knowing how many places shield contacts earth through damaged insulation, so cable path MUST be probed for entire distance between access points.

Isolate *grounded conductor* and shield from *both* access points. Clip Fault Locator transmitter test cord *RED* lead to grounded conductor and *BLACK* lead to *driven ground rod.* Insert test cord plug into transmitter output jack and set transmitter matching switch for proper match of fault. Use *ground return probe* connected to HIGH jack of receiver. Set reference point (normally mid-range) on receiver meter. Probe cable path every 4 to 5 feet resetting reference point on receiver meter as necessary. As fault location is approached signal level will suddenly increase (peak) on receiver meter. PROBE IN INCHES. Directly over fault there will be a NULL (minimum signal) on receiver meter. Mark exact location of NULL as it is the exact location of a *fault* whether conductor to shield or shield to earth is not known at this time. Immediately after passing fault point there will be another sudden increase in signal (peak) on receiver meter. Continue probing as entire length of cable path between access points MUST be probed noting all peak *NULL* peak indications on receiver meter and marking exact location of each *NULL.*

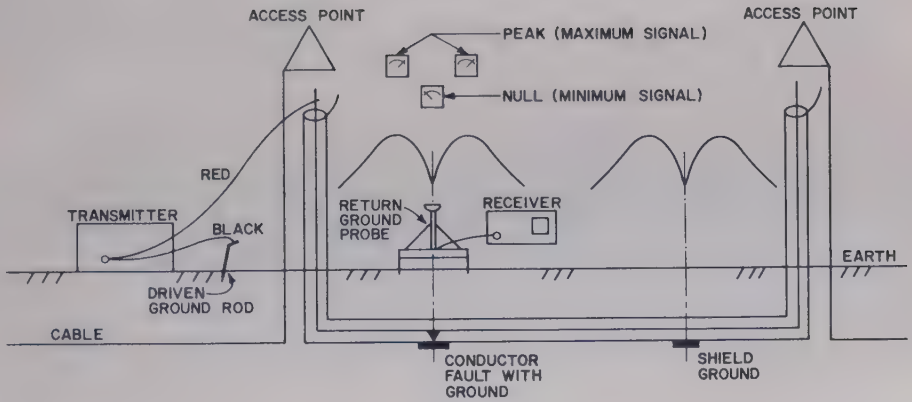
If only one peak NULL peak indication is found while probing entire cable path return to the MARKED NULL point as grounded conductor to shield and through damaged insulation shield contacts earth at same point.

HOWEVER, if more than one peak NULL peak indications are noted *MARK* exact location of each NULL seen on receiver meter as cable path is probed. One of these *NULLS* will be location of grounded conductor to shield *fault.*

Return to Fault Locator transmitter with receiver and ground return probe and disconnect transmitter test cord plug from transmitter output jack. Unclip *RED* lead of test cord from grounded conductor and clip to *shield.* Leave *BLACK* lead clipped to *driven ground rod.* Insert test cord plug into transmitter output jack and set transmitter matching switch for proper match of fault. Use ground return probe connected to *HIGH* jack of receiver. Return to each *NULL* area marked previously and after setting reference point on receiver meter probe area again. *A REPEAT* of peak *NULL* peak indicates a *shield* to *earth fault* with insulation damage.

However, if NO peak *NULL* peak indication is seen on receiver meter at one previously marked *NULL* location *grounded conductor* to *shield* fault point has been located.

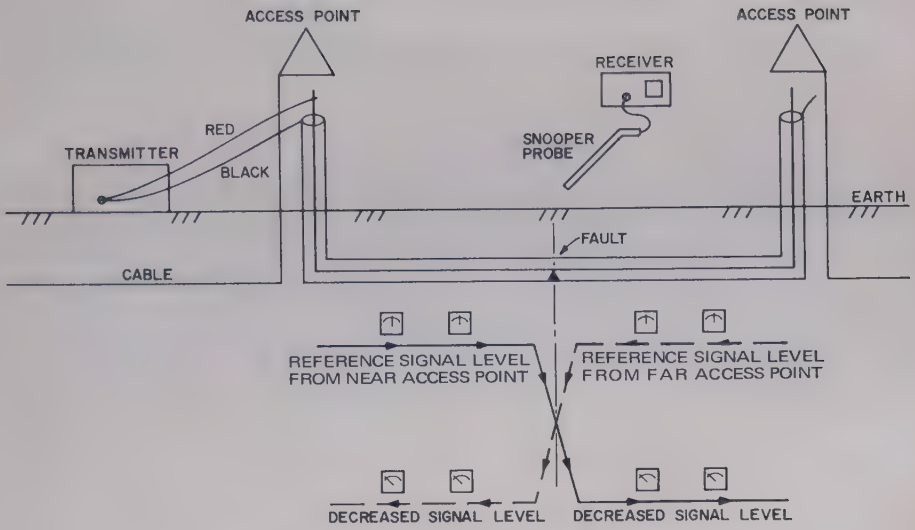
In case each peak *NULL* peak is repeated then grounded conductor is located at one of the previously marked *NULL* points. In this case all *NULL* points must be dug and investigated to locate grounded conductor.



Example 3a. Conductor Ground with Shield Ground

Grounded conductor — shield not damaged.

Isolate *grounded conductor* and *shield* from both access points. Clip Fault Locator transmitter test cord *RED* lead to *grounded conductor BLACK* lead to *shield*. Insert test cord plug into transmitter output jack, and set transmitter matching switch for proper match of fault. Use snooper probe connected to *LOW* jack of receiver. Set reference point (normally mid-range) on receiver meter and proceed to probe cable path. Note a good signal level until you reach fault area where signal level definitely *decreases* (2 to 4 divisions) on receiver meter. Mark where signal starts to drop off and where it starts to level off. Usually fault is halfway between these marks. ALWAYS verify that fault is definitely between marked locations by going through above procedures from other access point. Mark where signal starts to drop off and where it starts to level off. These marks should be within *inches* of the first points marked. Dig and expose cable in this area (usually 2 to 3 feet). Use snooper probe directly on top of cable. Fault is located at point where receiver meter indicates a definite *loss* of signal.

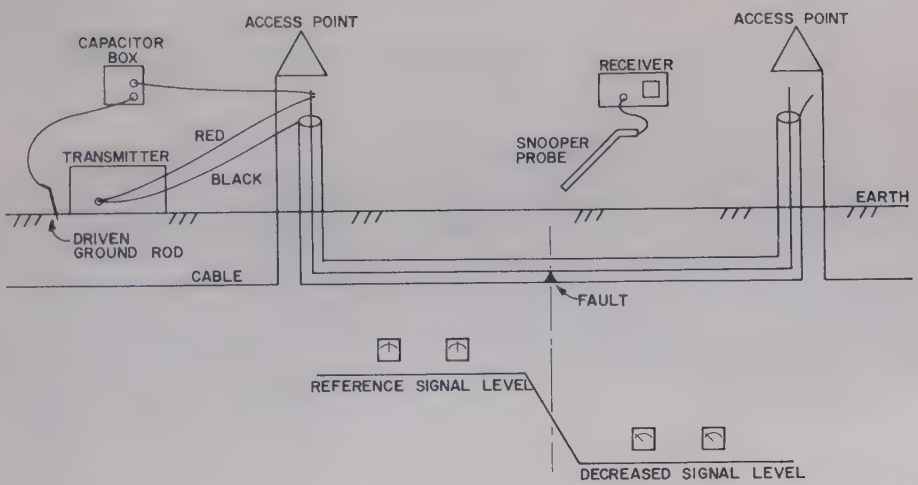


Example 3b. Conductor Ground with no Earth Return

GROUNDED CONDUCTOR – SHIELD NOT DAMAGED.

Capacitor substitution method used on high resistance ground.

Isolate the *faulted conductor* and *shield* at *both* access points. Clip Fault Locator transmitter test cord *RED* lead to *grounded conductor* and *BLACK* lead to *shield*. Insert test cord plug into transmitter output jack and set matching switch for proper match of fault. Clip capacitor box (Back of book Ramblings), one lead to grounded *conductor* and other lead to driven *ground rod*. Select capacitor value that will cause the transmitter matching meter level to increase. Use snooper probe connected to *LOW* jack of receiver. Set reference point (normally mid-range) on receiver meter, and proceed to probe cable path. Note a good signal level until fault area is reached where signal level definitely *decreases* (2 to 4 divisions) on meter scale. Mark where signal starts to drop off and where it starts to level off. Usually fault is halfway between these two marks. *ALWAYS* verify that fault is definitely between marked locations by going through above procedures from other access point. Mark where signal starts to drop off and where it starts to level off. These marks should be within inches of the first points marked. Dig and expose cable in this area (usually 2 to 3 feet). Use snooper probe directly on top of cable. Fault is located at *point* where receiver meter indicates a definite *loss* of signal.



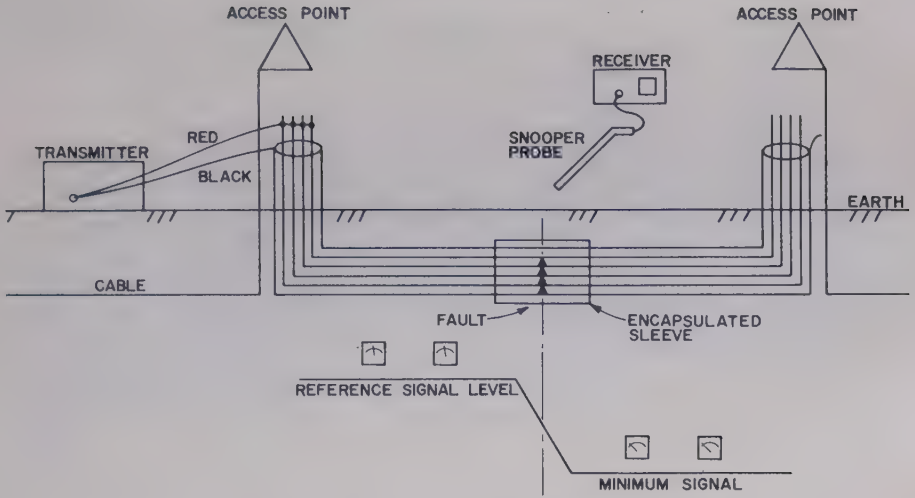
Example 3c. High Resistance Grounds Shield not Damaged

WETS: Conductors to shield ground at encapsulated splice case through moisture – a *difficult fault to locate.*

This type of fault is man made – defective epoxy or carelessness when originally encapsulated. If only one or two conductors are wet, fault can be found but is usually very difficult.

Isolate *ALL wet conductors* and *shield* from *both* access points. With ohmmeter measure *resistance* between each wet conductor to shield at both access points. Clip Fault Locator transmitter test cord *RED* lead to *ALL* wet conductors at access point where lowest resistance measurements between wet conductors and shield was noted. *BLACK* lead to shield. Insert transmitter test cord plug into transmitter output jack. *TRANSMITTER POWER NEEDED* MINIMUM – just enough so signal can be heard in headset and seen on receiver meter while probing to fault with level control on receiver as fully clockwise as possible without overloading receiver. If too much transmitter power is used it will cause "Flooding", "Carry-Over", or "Carry-By". (Transmitter signal does not stop at fault but through capacity or resistance, goes beyond fault).

Use snooper probe connected to LOW jack of receiver. Using this method there will be a *NULL* (little or no signal) directly over cable with maximum signal on either side of cable. Use the maximum signal on one side of cable for probing. At *fault* signal will stop. If fault cannot be located from first access point try from other access point.



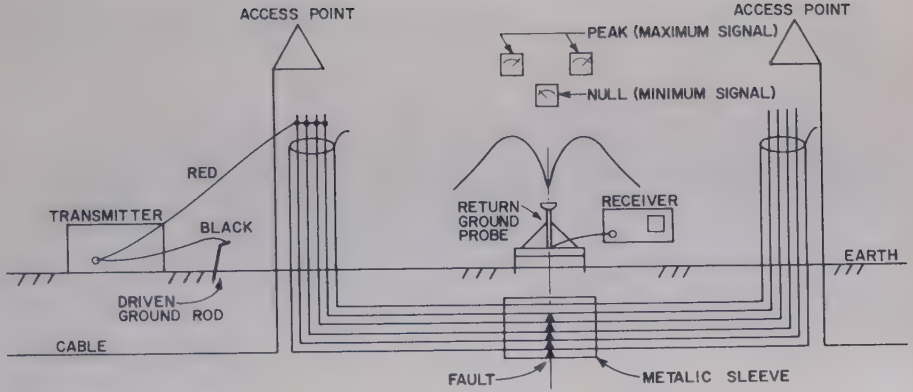
Example 4a. Wet in Encapsulated Sleeve

WETS: Conductor or conductors to earth at metallic splice case through moisture. Normally an easy fault to locate.

Isolate *ALL faulted conductors* and *shield* from *both* access points. Clip Fault Locator transmitter test cord *RED* lead to *ALL faulted conductors*. *BLACK* lead to driven ground rod. Insert transmitter test cord plug into transmitter output jack and set transmitter matching switch for proper match of fault.

Use *Ground Return Probe* connected to *HIGH* jack of receiver. Set reference point normally mid-range) on receiver meter. Probe cable path every 4 to 5 feet, resetting reference point on receiver meter as necessary. As fault location is approached signal level will suddenly increase (peak) on receiver meter. *PROBE IN INCHES*. Directly over fault there will be a sharp *NULL* (minimum signal) on receiver meter. (Receiver meter reading will increase by moving Ground Return Probe 1 to 2 inches). Immediately after passing fault point there will be another sudden increase in signal (peak) on receiver meter. When Ground Return Probe is on cable path and centered over fault, (NULL reading on receiver meter) fault is directly in line with handle of Ground Return Probe.

NOTE: If there are two or more metallic splice cases on cable under test, there will be a *NULL* over each one. However, the *NULL* at fault will be *sharp*, while *NULL* over other metallic splice cases will be broad, approximately 3/4 actual length of splice case. Refer to page 15 for further information on metallic sleeve.



Example 4b. Wet with Metallic Sleeve

SHORTS

A "pure" short with no other associated fault is one of the more difficult type of trouble encountered in buried or underground cable and will take more time to locate. Always test *both shorted conductors* and *shield* at both access points for associated fault(s). If associated fault(s) are found locate and clear same before trying to locate short. (Always confirm fault location by testing from both access points). On high density cable – "picket fencing" (signal level rising & falling) may be observed on receiver meter. This is caused by actual physical location in cable of circuit under test.)

NOTES: On "pure" *short* peaked signal will be noted over cable – NO NULL.

On *short* with associated earth ground (earth ground can be so small ohmmeter will not read), – NULL *will be directly* over *cable.*

Three methods of locating shorts are used. It is recommended that toning a metallic loop, be tried first.

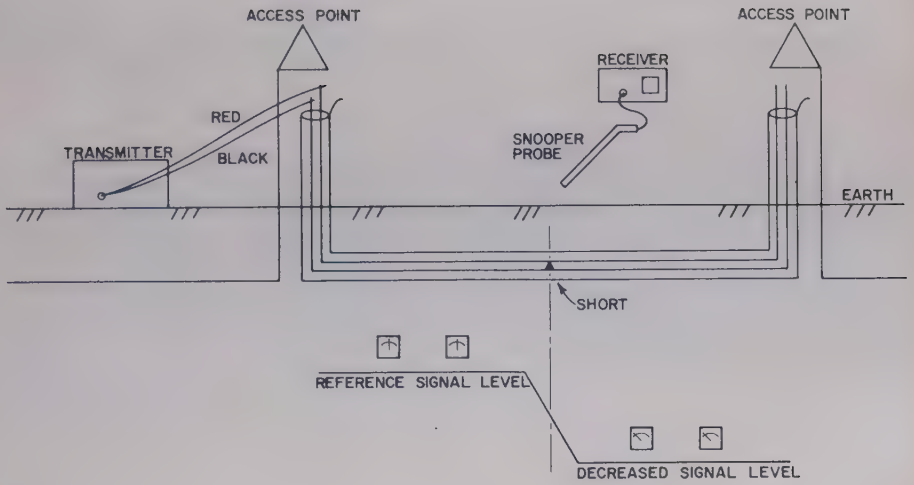
Toning a metallic loop

Adding good pair to shorted pair. This adds capacity which permits tone to be heard in headset and seen on receiver meter while probing.

Adding capacity to one conductor of shorted pair for high resistance shorts when no spare pair available.

SHORT-METALLIC LOOP

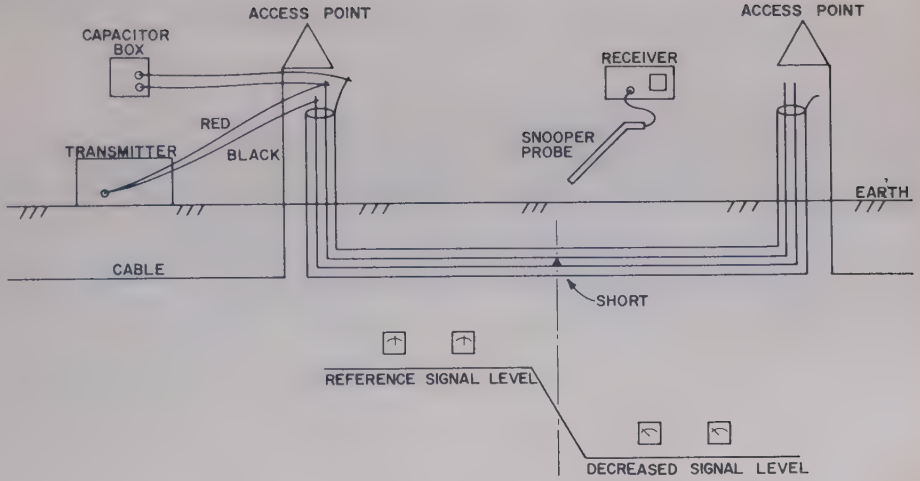
Isolate *faulted pair* and *shield* at *both* access points. Clip Fault Locator transmitter test cord to shorted pair. Insert test cord plug into transmitter output jack. Set transmitter matching switch for proper match of fault. Use snooper probe connected to LOW jack of receiver. Set reference point (normally mid-range) on receiver meter and proceed to probe cable path. Reset reference point as necessary. Note a good signal level until fault area is reached, where signal level definitely *decreases* (2 to 4 divisions) on meter scale. Mark where signal starts to drop off and where it starts to level off. Usually fault is halfway between these two marks. *ALWAYS* verify that fault is definitely between marked locations by going through above procedures from other access point. Mark where signal starts to drop off and where it starts to level off. These marks should be within *inches* of the first points marked. Dig and expose cable in this area (usually 2 to 3 feet). Use snooper probe directly on top of cable. Fault is located at point where receiver meter indicates a definite *loss* of signal.



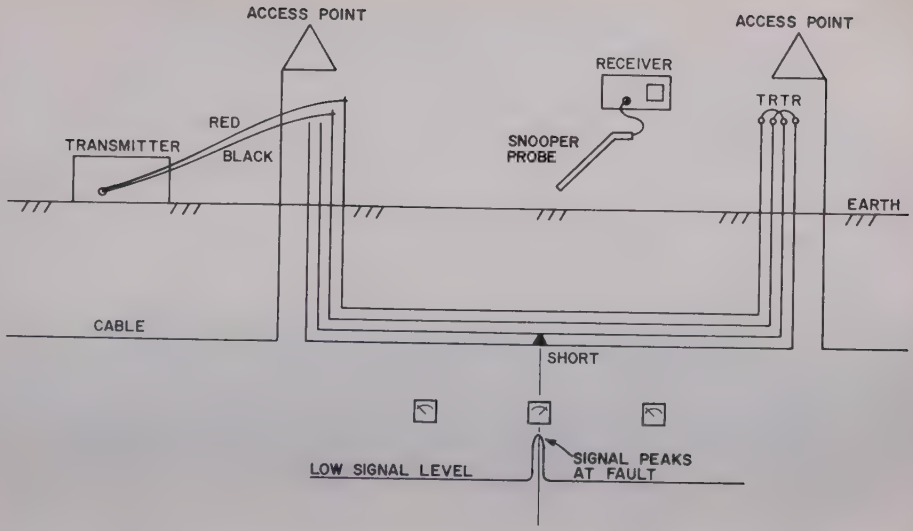
Example 5a. Short Metallic Loop

SHORT: Adding capacitor to one conductor of shorted pair for high resistance short. Capacitor box described in "Back of Book Ramblings".

Isolate the *faulted pair* and *shield* at *both* access points. Clip Fault Locator transmitter test cord to shorted pair. Insert transmitter test cord plug into transmitter output jack and set transmitter matching switch for proper match of fault. Clip capacitor box one lead to conductor connected to *transmitter with RED lead* and other lead to shield. Select capacitor value that will cause the transmitter matching meter level to increase. Use snooper probe connected to *LOW* jack of receiver, set reference point (normally mid-range) on receiver meter and proceed to probe cable path. Note a good signal level until fault area is reached, where signal level definitely *decreases* (2 to 4 divisions) on meter scale. Mark where signal starts to drop off and where it starts to drop off and where it starts to level off. Usually fault is halfway between these two marks. ALWAYS verify that fault is definitely between marked locations by going through above procedures from other access point. Mark where signal starts to drop off and where it starts to level off. These marks should be within *inches* of the first points marked. Dig and expose cable in this area (usually 2 to 3 feet). Use snooper probe directly on top of cable. Fault is located at point where receiver meter indicates a definite *loss* of signal.



Example 5b. Short Capacitor Substitution

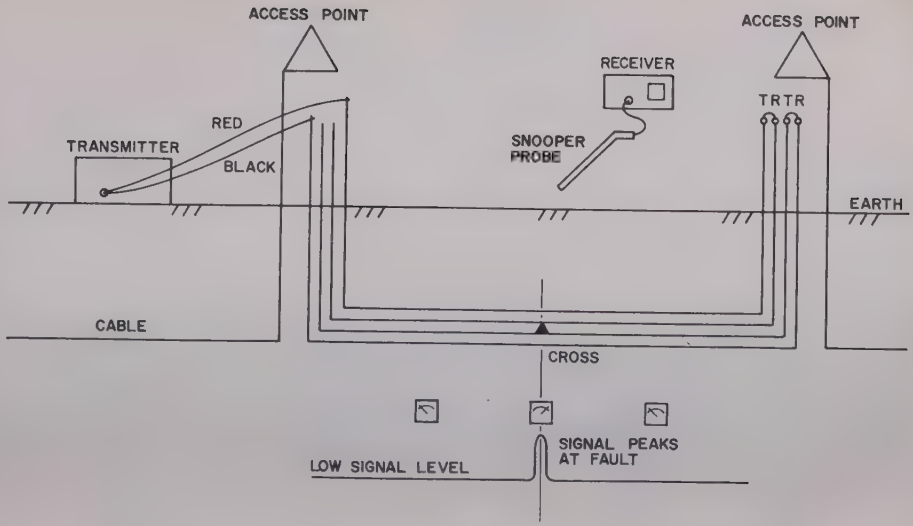


Example 5c. Short Location using Pair Substitution

SHORT: Adding good pair from another bundle or group to faulted pair for location of high resistance shorts.

Isolate *faulted pair* and *shield* at *both* access points. Connect good pair from another bundle or group to faulted pair at far access point, tip to tip, and ring to ring. Clip Fault Locator transmitter test cord *RED* lead to tip, *BLACK* lead to *ring* of GOOD pair. Insert transmitter test cord plug into transmitter output jack. Set transmitter matching switch for proper match of fault. Use snooper probe connected to LOW jack of receiver. Note: Use this method *signal* will be *LOW* and reference level can *not* be set on receiver meter, but signal MUST be heard in headset and seen on receiver meter. Probe cable path until fault area is reached -- signal level will suddenly increase (peak). Fault is located at peak. After passing fault signal will again be *LOW*. Dig and expose cable at peak signal location. Use snooper probe directly on top of cable. Fault is located at *point* where receiver meter indicates a *sudden increase* in signal.

CROSSES: This fault may be treated the same as a short, as a metallic loop or as explained in drawing. Usually this type of fault test the same as a short or as above.



Example 5d. Cross

CUT CABLE: See attached Drawing, page 34.

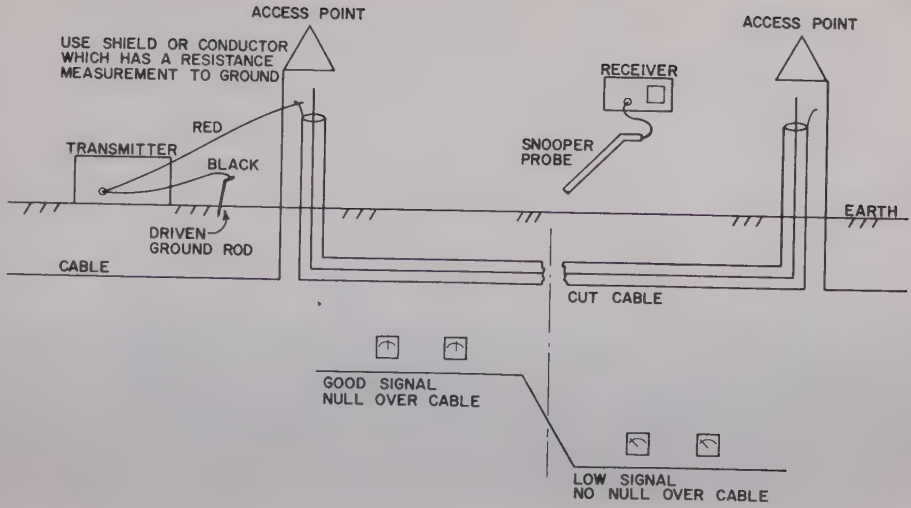
Normally a cut cable can be located by visual inspection. If, however, ends are buried same can be located providing shield or one conductor can be found that contacts earth at cut end.

Using ohmmeter isolate shield and conductors, as needed, from access point until operator finds one that will show resistance to earth.

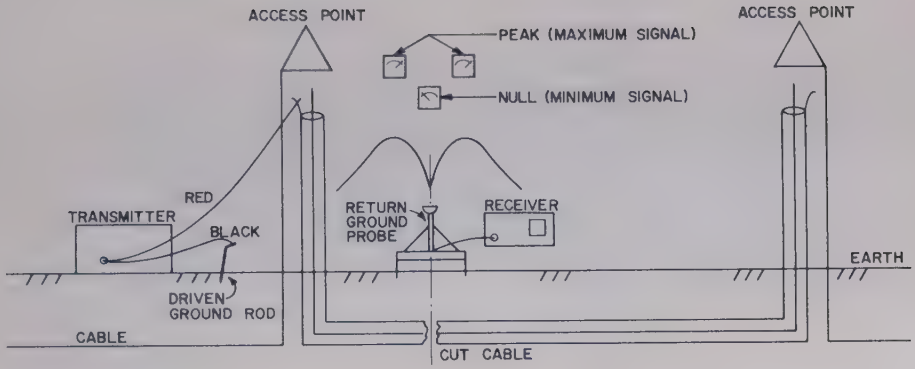
Connect transmitter test cord *RED* lead to this *shield* or *conductor* that shows resistance to earth, and *BLACK* lead to *driven ground rod.* Insert test cord plug into transmitter output jack. Set transmitter matching switch for proper match of fault. Use snooper probe connected to *LOW* jack of receiver.

NOTE: Using this method there will be a *NULL* (minimum signal) directly over cable and a peak (maximum) signal on either side of cable. Set reference level (normally mid-range) on receiver meter on peak signal on one side of cable. Probe cable path until fault area is reached. Peak signal will show a slight increase, then *NULL* will be *lost* over cable. Beyond loss of *NULL* again a slight increase in signal. *LOSS* of *NULL* over cable pinpoints end of cut cable.

Ends of cut cable can be located using ground return probe, if shield or one conductor can be found that contacts earth at cut end. Connect transmitter test cord *RED* lead to this shield or conductor that contacts earth at cut end and *BLACK* lead to *driven ground rod.* Use same procedure as used in locating *shield* to *earth fault.*



Example 6a. Cut Cable using Snooper Probe



Example 6b. Cut Cable using Ground Return Probe

LOCATING SPLITS AND CORRECTED SPLITS:

This fault is always man made and is generally on two ring conductors.

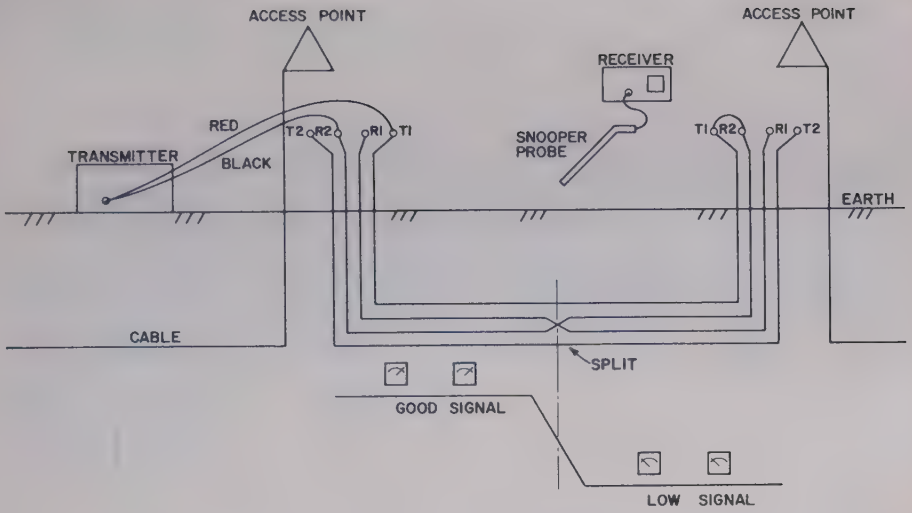
Isolate the four conductors (2 pair) that contain split from both access points. (It is not necessary to isolate shield to locate this fault). ASSUMING SPLIT BETWEEN 2 RING CONDUCTOR as per example shown. Clip one tip conductor and one ring conductor together at far access point. Clip Fault Locator transmitter test cord *RED* lead to the *TIP* conductor and *BLACK* lead to the *RING* conductor that through *SPLIT* is clipped together at far access point. Insert transmitter test cord plug into transmitter output jack. Set transmitter matching switch for proper match of fault. Use snooper probe connected to *LOW* jack of receiver. Set reference point (normally mid-range) on receiver meter and proceed to probe cable path. Note good signal level until fault area is reached, where signal level definitely decreases (2 to 4 divisions) on meter scale. Mark where signal starts to drop off and where it starts to level off. Fault is halfway between these marks.

NOTE: If T1 has been clipped to R1 at far access point (in example) with transmitter test cord, *BLACK* lead clipped to R1, signal would be *LOW* to fault area and high after passing fault. (Actual physical separation of conductors in cable causes this difference.)

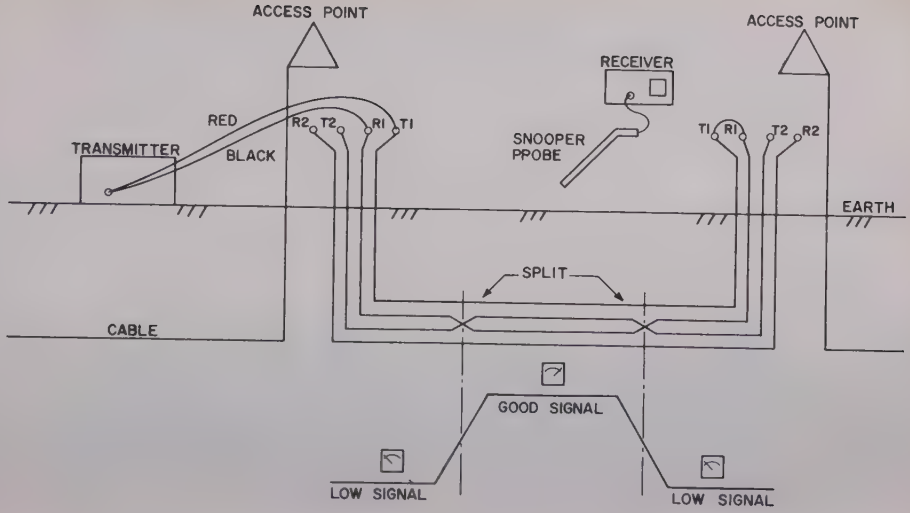
Corrected Split: Use exactly the same procedure as above. *DEPENDING ON HOOK UP* operator will have a low signal to first split, good signal to other split and low signal thereafter:

OR

Operator will have a good signal to first split, low signal to other split and good signal thereafter. Again change in signal level will show location of splits.



Example 7a. Split



Example 7b. Corrected Split

BACK OF BOOK RAMBLINGS

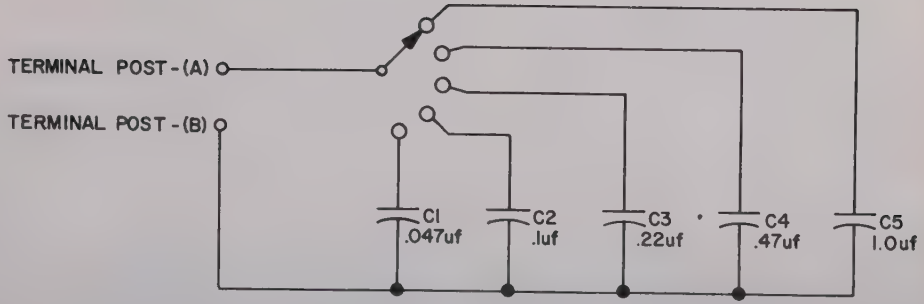
The "Back of the Book" section is devoted to special problems which I have personally worked on and have proven to be successful in locating, using the RYCOM Buried Cable Fault Locator.

It seems as though troubles in buried cable, have been easy to locate at times and other times very difficult even though the same conditions are similar.

One important item to always keep in mind when testing a cable is to check the fault for possible C.O. battery, as this one condition will lead you astray and not allow you to locate the actual fault. I recommend that all battery be removed from the faulted pairs even if it is necessary to remove a subscriber from service temporarily. This holds true on conductor faults such as wets, crosses, and grounds, as your tone will always carry you by the fault back to the C.O.

You may have noted that we use a capacitor substitution box in some of the drawings in the "How To Do It" section. This capacitor box was found to be very useful in locating certain types of faults, where the voltage and current are balanced and no signal is heard after leaving the pedestal or access point. Using the capacitor box to unbalance the fault the circuit permitted us to hear the tone and follow the cable to the faulted area. The circuit and values used in the capacitor box are illustrated for your information.

We made this capacitor box using five (5) values of capacity to actually simulate capacity of pairs. This unit was built in a small metal box using a one pole-six position switch, five (5) capacitors and two (two) terminal post. Most of these parts can be found around the warehouse, central office, or procured at the local T.V. repair shop or local radio supply house. All capacitors are rated at 200 volts D.C., working, the values are listed in Example 8.



Example 8. Capacitor Substitution Box

In this section we are devoting our attention to the location of open conductors in both buried and aerial cable, using return ground probe, capacity probe, (W.E. 111) and the capacitor substitution method with the RYCOM Fault Locator.

Many times in the past RYCOM has stated if a pure open is found in direct buried cables or drops using the RYCOM Fault Locator, consider yourself lucky. This statement is no longer true. Opens have been found many times in buried drops and buried cables. There is every reason to believe that using the methods outlined in this section, success will be achieved. We offer the following methods for your experimentation.

In example 9(a) and 9(b) we are illustrating two methods used to locate opens in buried drops. Using example 9(a) the following steps are outlined:

1. Isolate conductors and shield at both access points.
2. Clip all conductors and shield to a driven ground rod at far access point.
3. Clip Fault Locator transmitter test cord Red lead to open conductor and Black lead to driven ground rod.
4. Insert transmitter test cord plug into transmitter output jack and set transmitter matching switch to position 5.
5. Use ground return probe connected to high jack of receiver.
6. Turn level control on receiver clockwise until signal indication is seen on the receiver meter and heard in the headset. Probe cable path every 3 to 4 feet.
7. Meter reading may decrease or you may lose signal entirely, but keep probing. As you approach the fault you will note a sudden increase in receiver meter reading (usually 2 to 3 divisions). Continue probing but decrease the length of probing to inches. When you reach a point

where meter nulls (minimum signal) you are over the fault. Open is directly in line with the return ground probe handle.

Opens using the *capacitor substitution method,* with the Fault Locator.

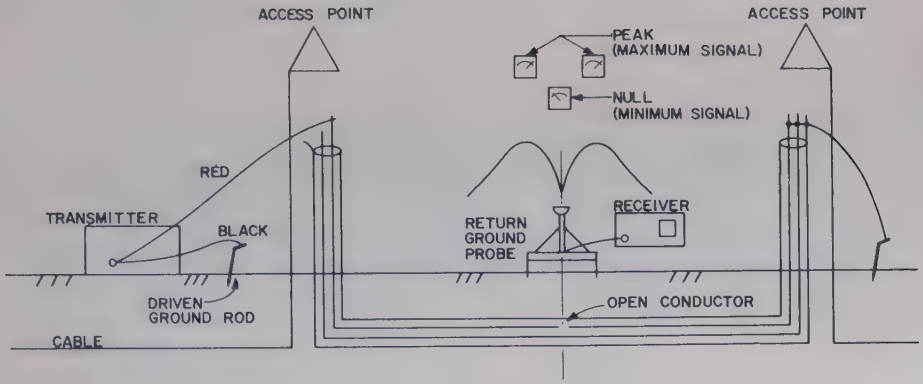
Field trials were conducted using the capacitor substitution method across the open side to good side pair, as illustrated in example 9(b).

Attach transmitter Red lead to open conductor, Black lead to opposite side of pair. Attach capacitor box between Red lead and Black lead. Ground conductors and shield at far end.

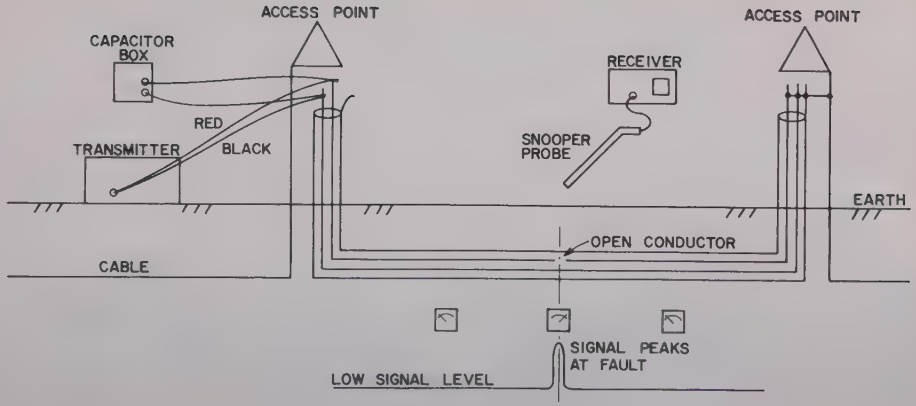
Set transmitter matching switch to position (5), step capacitor box through to right capacitor to cause transmitter matching meter to read into Green area.

Using the Snooper Probe insert test cord into Low jack and set gain level for a reference level of (5). Proceed to probe cable path noting null directly over the cable as though tracing path. At the fault a very decided increase will be noted. After passing the fault area a Loss of signal is noted. Your fault is at the peak or loudest signal point.

This same procedure was used in cable and I recommend it for aerial as well as buried cable.



Example 9a. Open Conductor in a Buried Drop Wire



Example 9b. Open Conductor in a Buried Drop Wire using Capacitor Box

USING THE MODEL 2785 TO LOCATE AERIAL TROUBLES

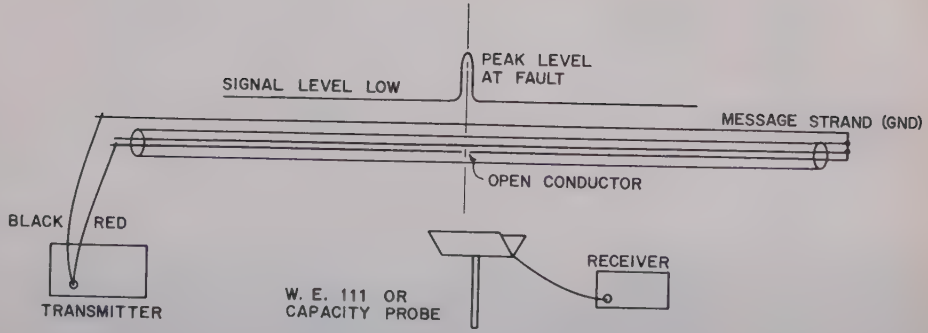
The Fault Locator may be used with any of the aerial exploring coils presently used with other equipment, or you may use our Snooper Probe directly below the cable.

In all cases aerial faults are in most cases identical to faults in buried cables and the drawings for buried cable troubles should be used with aerial cable faults, except on grounds and it is necessary to use the inductive type probes. The return ground probe is never used in aerial plant trouble shooting.

LOCATING OPENS — SHIELDED AERIAL CABLE

USING THE CAPACITY PROBE — W.E. 111 or Similar

Locating opens in shielded aerial cable is much easier than in buried cable. Isolate the open down to one or two spans. Accomplish this by testing between terminals, shorting the pair at one terminal and measuring for continuity on the pair at other terminal. When no continuity is measured between terminals we have located the faulted section of cable. Isolate faulted pair from *both* terminals. Clip transmitter test cord *RED* lead to *open conductor, BLACK* lead to opposite *conductor* and *shield.* Insert test cord plug into transmitter output jack and set transmitter matching switch on highest position (5). Use capacity probe connected to HIGH jack of receiver. Lay capacity probe up to cable and listen for tone. This is usually very low, but can be seen and heard. Probe cable to point where signal peaks, this is your *OPEN.* To verify this you may switch your tone to the opposite terminal and duplicate your test.



Example 10a. Open Conductor in Aerial Cable (Shielded) using Capacity Probe

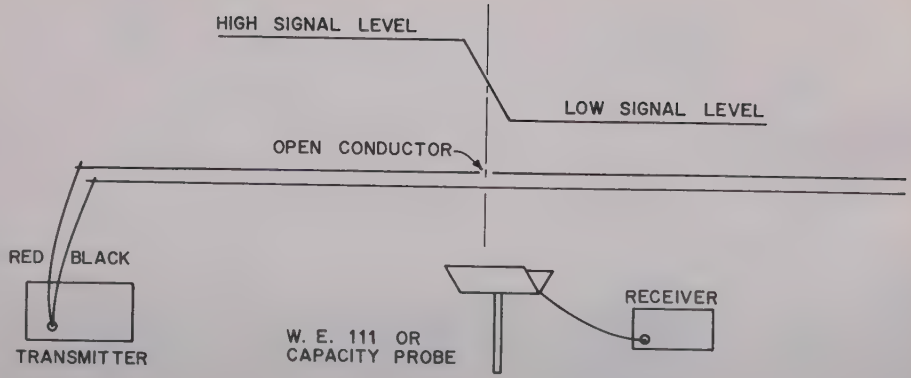
LOCATING OPENS IN UNSHIELDED CABLE.

USING THE CAPACITY PROBE — W.E. 111 or Similar

Locating opens in unshielded cable is very simple. Isolate open down to one or two spans (same as in shielded aerial cable).

Isolate faulted pair from both terminals.

Clip transmitter test cord *RED* lead to *open* conductor, *BLACK* lead to opposite conductor. Insert test cord plug into transmitter output jack and set transmitter matching switch on highest position (5) cable. Use capacity probe connected to HIGH jack of receiver. Set gain on receiver until signal is seen on meter and heard in headset. Probe cable until signal stops. Fault is at point where signal is lost.



Example 10b. Open Conductor in Aerial Cable (Unshielded) using Capacity Probe

USING RYCOM'S MODEL 2785 TO LOCATE FAULTS IN BURIED SECONDARY AND PRIMARY SERVICE WIRES

The Model 2785 Fault Locator is used to locate troubles in underground power distribution systems as well as in communication cables. In this application troubles such as grounded, shorted, and open conductors may be located in the same manner as in communication cables.

Experience with several companies using the Model 2785 to locate troubles has proven very successful, for instance, on open conductors it has been noted that this trouble usually goes high resistance to ground on one or the opposite sides of the open conductor. By using the return ground probe this type of fault may be located very quickly.

In cable where damage has occurred through digging, usually this marks the cable and due to the small amount of insulation at this point, with current and voltage present, will soon start to arc and eventually go to ground. This type of trouble is located with the return ground probe.

Most of the troubles we have experienced in power cables has indicated that a great majority have been grounded conductors, and these faults have proven very easy to locate.

The following examples are methods using the ground return probe to locate grounded and open conductors.

Grounded Conductor Phase 1
Buried Secondary Leads

For this type of fault it is necessary to de-energize the several leads. Attach Model 2785 transmitter test leads to grounded conductor and a ground rod. Adjust transmitter matching position for correct match indicated on the transmitter meter. Using the return ground probe proceed to probe along cable route observing Receiver meter. It will indicate an increase in signal level as you approach the faulted area. When you are close to the fault the meter will indicate a very high reading, at this point readjust amplifier gain until maximum indication is mid-scale. Continue probing and it may be necessary to again turn the gain down to keep your meter on scale. When you are directly over the fault your meter will dip down to approximately 0 reading of the meter. At this point your probe handle should be directly over the fault. Proceed probing and as you go through the fault an increase in level will be noted on your meter. Return to area where the lowest reading occurred between the maximum points and at the lowest point you will find your faulted conductor.

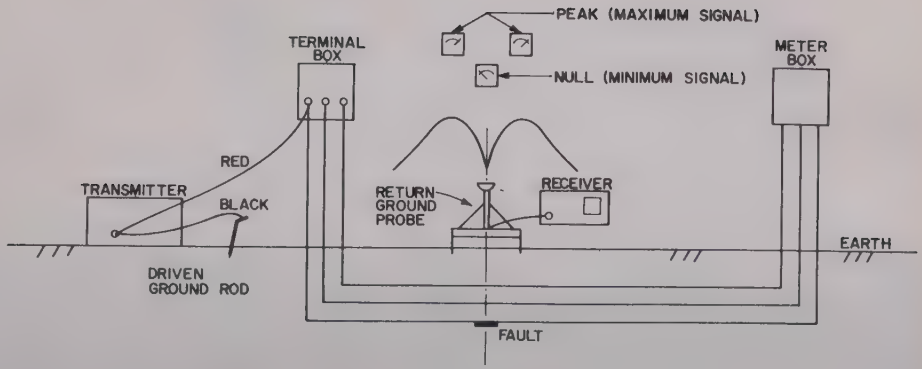
Open Conductor Phase 1
Buried Secondary Lead

This fault may be located in the same manner as described in the grounded conductor. Again it is necessary to de-energize the leads to test. Using an ohmmeter, test between conductor and ground. A slight indication should be noted if the side goes to ground, if test indicated no resistance measurement from either side, you may attach the Model 2785 Fault Locator to the open conductor and place matching switch into position 5. At this point I try both sides of the conductor to see which side will indicate heaviest loading. The side where the transmitter meter indicates closest to the Green area of the meter is taking the most load. This is the lead to attach the transmitter using the Red clip lead to the conductor and the Black lead to a driven ground rod.

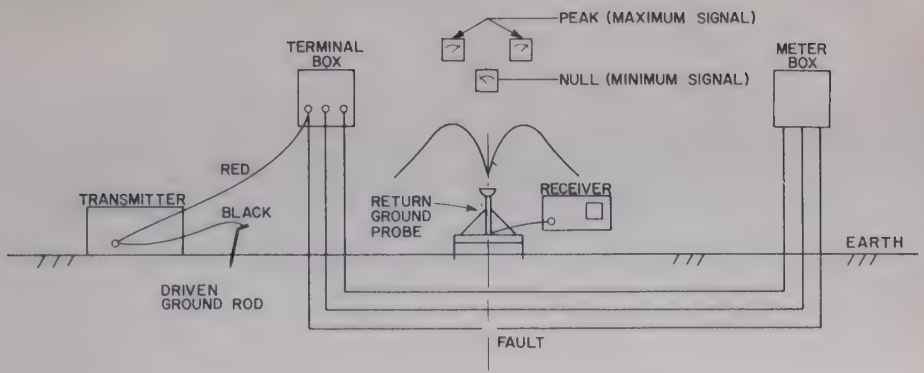
Using the same procedure as outlined for grounded conductor using the return ground probe, a peak, NULL and peak in signal level will indicate fault at NULL point.

The same procedures may be used on primary feed concentric lines between transformer pads. It is necessary to de-energize your lines for all of the tests outlined.

We might add that when aluminum conductors are used, and the above damaged areas located, it will usually be found that the conductor is open except for an extreme high resistance path.



Example 11a. Grounded Conductor 1 Phase Buried Secondary Lead



Example 11b. Open Conductor 1 Phase Buried Secondary Lead

SPECIFICATIONS FOR RYCOM MODEL

2785 FAULT LOCATOR

Transmitter:

- Frequency ..... 815 Hz ± 2 Hz
- Pulse Rate ..... 7–10 pulses/sec.
- Power ..... 2–6 volt lantern batteries
- Weight ..... ten (10) pounds – approx.
- Size ..... 10½" x 8" x 6½"
- Function switch ..... 7 position; Off, Battery Test, 5 position for impedance matching

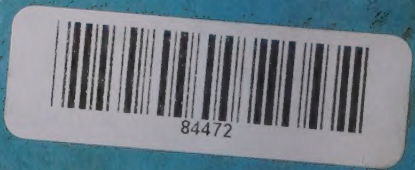
Receiver:

- Frequency ..... 815 Hz ± 5 Hz
- Filter Rejection ..... Greater than 100db at 540 Hz
  Greater than 85db at 1080 Hz
- Overall Gain ..... Greater than 115db
- Gain Control Range ..... 120db min.
- Power ..... 4 – "C" cells
- Weight ..... two (2) pounds, approx.
- Size ..... 5-5/8" x 2-7/8" x 5-1/4"

Ground Return Probe ..... Weight nine (9) pounds

Snooper Probe Tuned ..... 815 Hz ± 5 Hz

- Impedance ..... 150 Ohms
- Weight ..... one (1) pound approx.


84472